

## *BERNARDICHTHYS ZORRAQUINOSI*, A NEW GENUS AND SPECIES OF SALMONIFORM FISH FROM THE LATE CRETACEOUS OF OREGON

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*Abstract.*—Field samples from the Bernard Formation (lower Cenomanian) of Oregon contained a single well-preserved teleost otolith that represents a new genus and species, *Bernardichthys zorraquinosi* (Salmoniformes: Bernardichthyidae). A Kevex analysis of the otolith's composition revealed the presence of calcium, silica, aluminum, iron, potassium, and magnesium. This is in contrast to the composition of Pliocene otoliths from the Purissima formation which consisted only of calcium, probably in the form of aragonite. This specimen constitutes the third reported occurrence of Cenomanian age otoliths and the earliest reported occurrence of an otolith in North America.

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Samples collected by Bruce Welton from the basal Bernard formation, Oregon, yielded a single well-preserved teleost otolith. The Bernard formation, established by Dickinson and Virgrass (1965), lies unconformably on Paleozoic, Triassic, and Jurassic strata and is overlain unconformably by Tertiary volcanics. The formation is approximately 1500 feet (460 m) thick and consists of a pebbly sandstone to conglomerate with minor amounts of clayey sandstones and mudstones. From invertebrate data it is considered lower Cenomanian (lower-most upper Cretaceous age) by Dickinson and Virgrass (1965).

Although Koken (1891) first described Cretaceous otoliths from Europe, their occurrence in North America was not mentioned until some 64 years later when Tychsen and Vorhis (1955) reported, but did not describe, otoliths from the Fox Hills Sandstone (Maastrichtian age) of South Dakota. The first description of taxa based on Cretaceous age otoliths from North America followed ten years later when Frizzell (1965a, 1965b) described new genera and species of the families Albulidae and Vorhisiidae, the latter subsequently found to be a junior synonym of the family Ariidae (J. E. Fitch, personal communication). Discussions pertaining to Cenomanian age otoliths are restricted to reports concerning a single otolith and an otolith impression (Gowda, 1967a, 1967b; Stinton, 1973).

The otolith terminology follows that of Frizzell and Dante (1965); see Fig. 1. Additional terms used but not shown in Fig. 1 are: ventral furrow, a narrow depression below the sulcus parallel to the ventral margin; excisura,

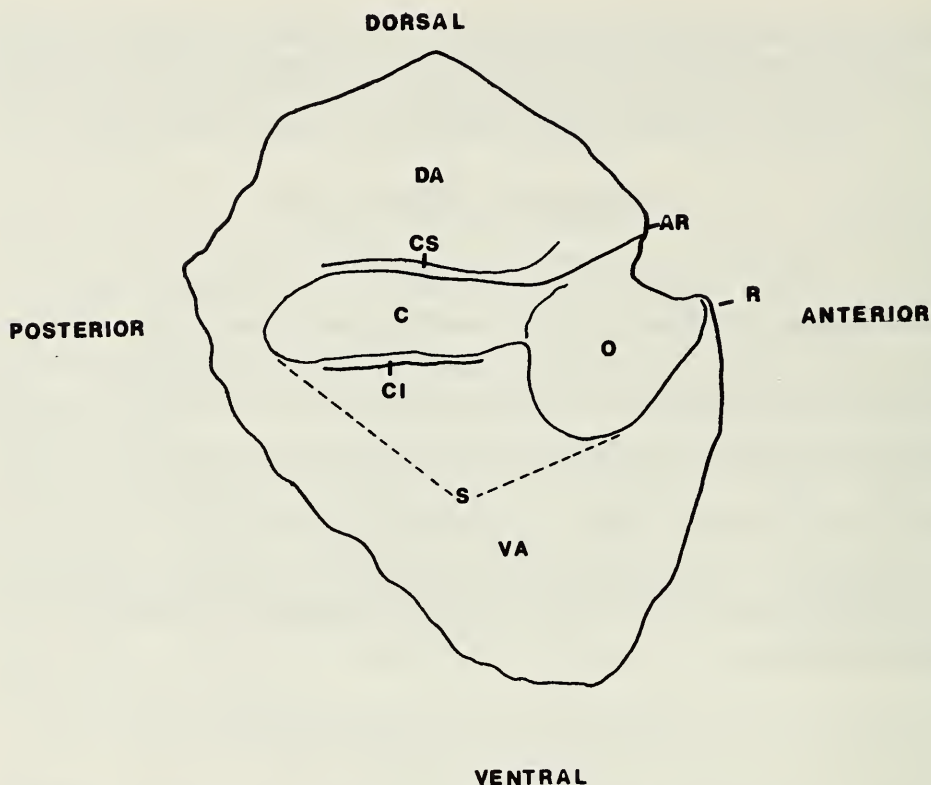


Fig. 1. Diagram of sagitta of *Antigonina eos* (Beryciformes: Antigoninidae) showing terminology used in this paper. AR, antirostrum; C, cauda; CI, crista inferior; CS, crista superior; DA, dorsal area; O, ostium; R, rostrum; S, sulcus; VA, ventral area.

a notch or indentation between the rostrum and antirostrum; and collum, a small ridge or division line between the ostium and cauda. The term otolith is a general term for three pairs of discrete elements occurring within the auditory labyrinth of fishes. These elements are the sagitta, asteriscus and lapillus.

Order Salmoniformes (*sensu* Greenwood et al., 1966)  
Bernardichthyidae, new family

*Type-genus.*—*Bernardichthys*, new genus.

The sagitta of the Bernardichthyidae differs from that of other families in the following combination of characters: nearly straight, horizontal cauda, lower margin of cauda straight, upper margin tapering posteriorly; short anteriorly expanding ostium; possessing a reduced rostrum, no antirostrum; lacking any form of depression on the dorsal area; lacking ventral furrow; possessing a deep ventral margin; lacking well defined crista superior and crista inferior as preserved (the sagitta displays some attrition which may have affected the crista superior and crista inferior); sulcus situated above

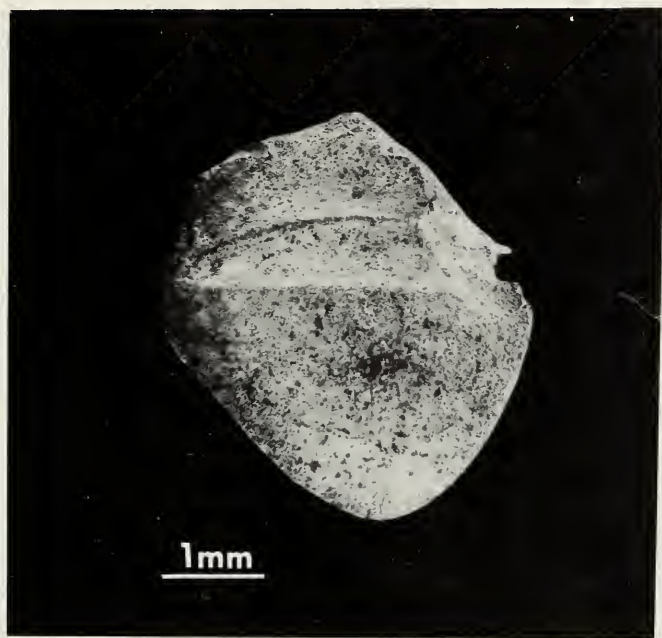


Fig. 2. *Bernardichthys zorraqinosi*, n. gen., n. sp. Holotype, LACM 4483/118693, left sagitta.

horizontal midline of sagitta; all margins smooth as preserved. Additional characters are as defined for the genus.

#### *Bernardichthys*, new genus

*Type-species*.—*Bernardichthys zorraqinosi*, new species.

*Diagnosis*.—Sagitta semi-ovate; dorsal margin angular; ventral margin broadly rounded, ventral margin asymmetrical, anteroventrally skewed; dorsal-ventral height greater than anterior-posterior length; sulcus horizontal, situated nearer dorsal margin; sulcus nearly straight; cauda narrow; dorsal rim of cauda slightly convex tapering posteriorly; ostium short, wider than cauda; excisura absent as preserved; ostium expanding anteriorly; rostrum weakly developed; crista superior and crista inferior weakly developed or absent as preserved; dorsal and ventral areas without depressions; ventral furrow absent.

#### *Bernardichthys zorraqinosi*, new species

Fig. 2

*Holotype*.—Complete left sagitta, Los Angeles County Museum of Natural History (LACM) 118693; Fig. 2.

*Type locality*.—LACM 4483, Bernard Formation, Crook County, Oregon; Lat. 44°06'52"N, Long. 119°40'42"W; in the NE ¼ of the SE ¼ of the NE ¼ of Sec. 11, T 17S, R 25E, Dayville map, 30 min. series. The site is ap-



proximately 3½ mi N of Saplee, Oregon and ½ mi NE of the Bernard Ranch, on the north side of Beaver Creek, on the southeast side of a northeast-southwest trending low ridge, in concretionary sandstone beds outcropping on the slopes of the ridge.

*Description.*—Small left sagitta, 3.76 mm antero-posterior length, 4.00 mm dorsal-ventral height, greatest thickness 0.84 mm; sagitta semi-ovate; inner face slightly convex; greatest thickness near sagitta midpoint; dorsal margin (see Fig. 1 for terminology) angular, posterodorsally inclined at a steep angle from the mid-ostium level, reaching greatest height at mid-sagitta, then posteroventrally inclined at a low angle; posterior margin posteroventrally inclined at a steep angle above sulcus, rounded at sulcus, anteroventrally inclined at a steep angle below sulcus; ventral margin deep, asymmetrically rounded, reaching greatest depth anterior of vertical midline of sagitta; ventral margin abruptly rounded at deepest point; anterior margin anterodorsally inclined below level of sulcus; anteriormost portion of sagitta missing, reconstruction of this area suggesting only a weakly developed rostrum; antirostrum and excisura not present as preserved; sulcus situated on dorsal half of sagitta; sulcus nearly straight, horizontal; ostium and cauda distinct; ostium short, elliptical, anteriorly expanding, open anteriorly; collum represented by a low posterodorsal-anteroventrally inclined shelf; cauda narrow, shallow, widest near collum, ventral margin of cauda straight, dorsal margin slightly curved, tapering posteriorly; cauda closed posteriorly, deepest along dorsal edge, uniformly shallowing to ventral edge; crista superior weakly developed as preserved; crista inferior absent as preserved; dorsal and ventral areas smooth, lacking depressions; ventral furrow absent; all margins smooth as preserved; outer face smooth, unsculptured.

*Comparison.*—The sagitta of *Bernardichthys zorraquinosi* differs from other otoliths by the following combination of characters: sagitta semi-ovate; angular dorsal margin; anterior margin with short pointed rostrum; posterior margin sharply rounded; ventral margin deeply rounded, deepest nearest anterior end; sulcus nearly straight, approximately horizontal, located on dorsal half of sagitta; ostium short, open anteriorly; weakly developed crista superior; absence of depressions on dorsal and ventral areas.

The slightly elevated position of the sulcus, the small distinct ostium, and the lack of an outward projecting flange on the dorsal portion of the sagitta prevent association of this form with the Osteoglossomorpha. The height-length ratio, well developed sagitta, nearly straight sulcus, and deeply rounded ventral margin of the sagitta prevent association of *Bernardichthys* with the Ostariophysi. The nearly straight sulcus, small ostium, relatively flat outer face, thin sagitta, deeply rounded ventral margin, and presence of a rostrum are within the acceptable limits of the Salmoniformes (*sensu* Greenwood et al., 1966). Several of these characters are reflected in mem-

bers of the families Osmeridae (Suborder Salmonoidei) and Argentinidae (Suborder Argentinoidei).

Sagittae of the extant Osmeridae and Argentinidae are characterized by a generally subangular external shape; strongly developed rostrum; straight, horizontal sulcus; deep subangular ventral margin; ventral margin usually reaching greatest depth nearest anterior end in the Argentinidae, nearest the posterior end in the Osmeridae; cauda either closed or open posteriorly; dorsal area with prominent depression in the Osmeridae, not pronounced or absent in the Argentinidae.

Greenwood et al. (1966) defined the Salmoniformes as containing eight suborders (Salmonoidei, Argentinoidei, Galaxoidei, Esocoidei, Stomiatoidei, Alepocephaloidei, Bathylaconoidei, and Myctophoidei). The straight horizontal sulcus, elevated position of the sulcus from the horizontal midline of sagitta, lack of a strong rostrum, and ovate sagitta differentiates the Bernardichthyidae from the Alepocephaloidei, Bathylaconoidei, Esocoidei and Galaxoidei. *Bernardichthys* differs from the Salmonoidei and Argentinoidei primarily by the lack of a well developed rostrum, absence of a subangular ventral margin, and the lack of shallow depressions on the dorsal area. The narrow cauda, wider ovate ostium, and curved dorsal rim of the cauda differentiates Bernardichthyidae from the Stomiatoidei. Among the Myctophoidei the characters are similar to the Harpadontidae, having the sulcus elevated to the dorsal half of sagitta, a well defined cauda margin, and a shorter rostrum.

The Bernardichthyidae is sufficiently distinctive to prevent assignment to any of the extant suborders of the Salmoniformes. It is advisable to leave the subordinal position of the Bernardichthyidae as *incertae sedis*.

*Discussion.*—A Kevex analysis of the sagitta of *Bernardichthys zorraquinosi* indicated the presence of the following elements, in order of significance: calcium, silica, aluminum, potassium, iron, and magnesium. With the exception of calcium these probably represent replacement of the original components which have been leached out. Similar analysis of otoliths from the Purissima formation (lower Pliocene) revealed only calcium, probably in the form of aragonite (Huddleston, unpublished data).

*Etymology.*—This species is named in honor of Joseph A. Zorraquinos of Rosemead, California, for his life-long pursuit of knowledge and science.

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### Literature Cited

- Dickinson, W. R., and L. W. Virgrass. 1965. Geology of the Suplee-Izee area, Crook, Grant and Harney counties, Oregon.—Bull. Oregon Geol. and Min. Indust. 58, 39 pp.
- Frizzell, D. L. 1965a. Otolith-based genera and lineages of fossil bonefishes (Clupeiformes, Albulidae).—Senck. Leth. 46a:85–110.
- . 1965b. Otoliths of new fish (*Vorhisia vulpes*, N. gen., N. sp. Siluroidei?) from Upper Cretaceous of South Dakota.—Copeia 1965(2):178–181.
- , and J. Dante. 1965. Otoliths of some early Cenozoic fishes of the Gulf Coast.—Jour. Paleontol. 39:687–718.
- Greenwood, P. H., D. E. Rosen, S. H. Weitzman, and G. S. Myers. 1966. Phyletic studies of teleostean fishes, with a provisional classification of living forms.—Bull. Amer. Mus. Nat. Hist. 131:339–456.
- Gowda, S. S. 1967a. The first fossil otolith from India.—Bull. Geol. Soc. India 4:15–17.
- . 1967b. On a new fossil fish known from an otolith from the South Indian Cenomanian.—Jour. Geol. Soc. India 8:119–129.
- Koken, E. 1891. Otolithes. In Bohm, J., De Kreidebildungen des Furbergs und Sulzbergs bei siegsdorf in Oberbayern.—Palaeontographica 38:37–40.
- Stinton, F. C. 1973. Fish otoliths from the English Cretaceous.—Palaeontol. Soc. Monogr. 2:57–126, pls. 4–8.
- Tychsen, P. C., and R. C. Vorhis. 1955. Reconnaissance of geology and ground water in the lower Grand River Valley, South Dakota.—U.S. Geol. Surv., Water-Supply Pap. 1298. 33 pp.

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